Remarks

Prior to this Amendment, claims 1-33 were pending in the application.

The Action mailed 12/14/2006 stated, in pertinent part, the following:

1) The Abstract was objected to as exceeding 150 words. A new Abstract is attached hereto on a separate page below.

2) The Action requested that the terms TOP-FLITE and TITLEIST be capitalized. This has been implemented by the present Amendment.

3) The Action requested that at page 10, line 1, the term "TS2" be changed to "ST2" . This has been implemented herein.

4) The Action noted that renumbering of the final few claims is required. This has been implemented herein.

5) The Action requested that in the claims, "prepositioned" be changed to "positioned". This has been implemented herein.

6) The Action requested that in claims 2, 10 and 25, the language "to determine predetermined angles" be changed to "to determine the angles for". This has been implemented herein.

7) The Action alleged that in claims 6 and 31, insufficient antecedent basis existed for "imaging system" and "single imaging means", respectively. The present Amendment attends to this point.

8) Claim 1 was rejected under 35 USC 102(b) as being allegedly anticipated by Mitoma (US 5611723, hereinafter simply "Mitoma"). The present Amendment and the following arguments address this point, as well as the other points of art-based rejections noted herein and in the Action.

9) Claims 1, 2, 4, 5-10, 12, 14, 19-21, 23, 25, 27-29 and 32 were rejected under 35 USC 103(a) as being allegedly unpatentable as obvious in view of Mitoma.

10) Claims 27 and 33 were rejected under 35 USC 103(a) as being allegedly unpatentable as obvious in view of a combination of Mitoma plus Welchman (US 6630998, hereinafter "Welchman") and Petry (US 5859923, hereinafter "Petry").

11) Claims 1, 6, 10, 13, 27, 30 and 31 were rejected under 35 USC 103(a) as being allegedly unpatentable as obvious in view of a combination of Mitoma and White (US 4972494, hereinafter "White").

12) Claims 1-3, 10, 11, 15-18, 22, 25 and 26 were rejected under 35 USC 103(a) as being allegedly unpatentable as obvious in view of a combination of Mitoma and Gordon (US 5632205, hereinafter "Gordon").

The Claims

Independent Claim 1 has been amended, without prejudice, to add recitations of claims 2, 3, 7-9, 11 and 23-24. Independent Claim 10 has been amended, without prejudice, to add recitations of claims 11 and 23-24. Independent claim 25 has been amended, without prejudice, to add recitations relating to Euler angles. Independent claim 27 has been amended, without prejudice, to add a recitation that the first and second workstations are substantially identical in structure. This Amendment also cancels claims 2-3, 7-9, 11, 17-21, 23-24 and 29-33 without prejudice, including without prejudice to re-filing such claims in a continuation case or otherwise. No new matter has been added, and support for the amended claims is found in the application, including collectively the specification, drawings and claims, as originally filed.

Among other aspects, the amended independent claims recite that multiple workstations are identical in structure, and that angles of rotation comprise Euler angles of rotation .phi, .theta plus an additional 90 degrees, and .psi, respectively.

In particular, among other aspects, amended claim 1 calls for:

(a) transposing means for conveying the spherical object between the first and second locating work stations in such manner that the spherical object is rotated through a single-degree of freedom by 90 degrees between the first and second locating work stations and between the second locating work station and the orienting means, respectively;

(b) the transposing means is operative to convey the spherical object to the second locating work station wherein the spherical object is rotated through the single-degree of freedom by 90 degrees such that the reference indicium is at the defined position and two dimensional orientation on the equator of the spherical object at the second locating work station;

(c) calculating means for processing the image of the spherical object generated at the first and second locating work stations, respectively, to locate and identify the defined position and two-dimensional orientation of the reference indicium and to determine angles for rotation for the spherical object by the orienting means;

(d) wherein the 90 degrees single-degree of freedom rotation provided by the transposing means between the first and second and the second and third orienting work stations are coplanar with the axes of rotation of the first, second, and third orienting work stations;

(e) the second locating work station is equal to and functions as the first orienting work station; and

(f) the determined angles of rotation implemented by the first, second, and third orienting work stations, respectively, comprise Euler angles of rotation .phi, .theta plus an additional 90 degrees, and .psi, respectively.

As discussed further below, this combination of features, among other claimed features, is neither taught nor suggested by the prior art; and similarly, the combinations of features recited by the other amended independent claims in the application are neither taught nor suggested by the prior art. This will be further established by the following discussion of the prior art.

The Cited References

Mitoma is directed to a burr-removing apparatus for golf balls. In particular, it discloses an apparatus for modifying the attitude of a golf ball having burrs formed thereon, the apparatus having a second station in which a CCD camera takes image data of the golf ball while rotating, one time, the golf ball around the X-axis by a step motor, and the rotational angle around the X-axis and that around the Z-axis, with which the equator having burrs formed thereon are required to be horizontal, are calculated in accordance with the image data; fourth and fifth stations in which step motors rotate the golf ball around the X-axis and Z-axis by the foregoing angles to-modify the attitude of the golf ball; and a sixth station in which a CCD camera takes image data of the golf ball to finely modify the attitude of the golf ball by step motors.

Welchman is directed to a system that purports to inspect game balls to check the quality of surface treatments applied thereto. The inspection system includes an imaging system including a detector for creating and providing an image signal of the ball being inspected to an analyzer. The inspection system also includes an environmental modification device to account for contours on the spherical surface of the ball such that the imaging system can create and analyze still images of the ball. A sorter or reject device, may be provided to act upon the ball based on an output signal from the analyzer.

Petry is directed to a machine vision system that purports to inspect a mark (such as a multi-character mark) on an integrated circuit device. The system provides search and defect analysis for the mark, individual characters of the mark, and the foreground and the background of the mark. The system provides for search and defect analysis reports thereof. It includes components for operator training search and defect analysis models for the whole mark, and for automatic training of such models for individual characters of the mark.

White is directed to a package inspection system that purports to measure predetermined parameters of cigarette packages, compares the measured parameters with predetermined values, evaluates from the measured parameters the integrity of the package and determines whether the packages is acceptable. The system views one or more package sides, using one or more line scan or area array cameras and/or optics to enable multiple package side images to be obtained using a single camera

Gordon is directed to apparatus purporting to achieve the spatial orientation of a game ball, using a camera for imaging the ball and its spatial orientation, a computer communicating with the camera for processing the image and for computing a required spatial rotation to bring the ball into a desired spatial orientation, and motors communicating with the computer for rotating the ball to a desired orientation without substantially moving the center of the spherical object.

The Combinations of Features Required by the Amended Claims are Neither Taught Nor Suggested by the Cited References

Based on the amended claims on the one hand, and the disclosures of Mitoma, Welchman, Petry, White and Gordon on the other, it will be seen that the combinations of features required by the amended claims are neither taught nor suggested by the cited references. The subject matter of the amended claims therefore is neither anticipated nor rendered obvious by the references, taken separately or in combination, and thus distinguish patentably over the art of record. It is therefore respectfully requested that the above-noted rejections be withdrawn and the amended claims be indicated to be allowable.

Greater detail is provided below, but at the outset, the Applicant notes that among other key differences over the prior art, the Applicant's claimed invention utilizes, in combination with the other claimed features, an efficient method of indexing the ball, not disclosed in the prior art,

by rotating it through one degree of freedom to simultaneously transfer the ball and present it to a second, mechanically identical station, so that the axis of rotation of the ball at the second station is perpendicular to the previous axis of rotation, while the two stations rotate on parallel axes. The teachings of Mitoma, for example, are fundamentally different from the claimed invention (compare, e.g., FIG. 7 of the present application vs. FIG. 1 of Mitoma) and in fact, diametrically opposed to the mechanisms and methods required by the claims. In addition to not employing the claimed single degree of freedom 90 degree transport and indexing (instead employing a far more complex lift, transfer and place conveyance arm that needs to move in multiple degrees of freedom as discussed below), Mitoma cannot orient in 3 dimensions in exactly 3 moves, as the claimed invention can. Mitoma is responsive to the "attitude" of the equator of the ball, since his system is essentially designed to enable deburring of the equator (presumably the seam on the ball), but cannot orient to a given point on the surface as the claimed invention can. A target "point" on the ball cannot be positioned by Mitoma, as it can be in the claimed invention; only a target "great circle" can be positioned by Mitoma.

Mitoma, in particular, fails to teach how to orient a ball in all three dimensions; does not use identical multiple workstations, parallel axes, and an indexing means that is coplanar with the axes of rotation at each station (thus allowing much faster indexing, as well as economies of scale and lower cost, while the parallel axes allow the stations to be located closer together, thus reducing the time required to transport and index the ball from one station to the next.) Using four parallel axes of rotation the stations can be positioned closer together than in the Mitoma machine, and this allows for the simplified indexing method, as claimed, of rotating the ball from one station to the next. This is significantly more efficient because it requires just one move (rotate) instead of three as in Mitoma (lift, transfer, and place). The closer positioning of the axes, combined with the single move, results in approximately doubling the operating rate.

Also unlike Mitoma, the claims call for using the first station as both an imaging station and a coarse orienting station. The second station is used as an imaging station and the first of multiple fine orienting stations. The indexing of the ball by rotating it from one station to the next is not described in or suggested by Mitoma.

The claims also call for coplanar axes, which is not taught in Mitoma, in that Mitoma's axes are not coplanar. Moreover, Mitoma does not teach a system where the axes are parallel or where the ball can be indexed by a single, 90 degree rotation of an indexing means. Having the

axes be parallel has the added advantage that the camera(s) can be isolated behind a pane of glass that is positioned between camera(s) and the balls, thus protecting the cameras and reducing maintenance requirements.

The Action notes that Mitoma in column 7, line 13 describes a conveyance arm that moves vertically as well as in a lengthwise direction (i.e., with two degrees of freedom), and alleges that this somehow teaches or renders obvious the Applicant's claimed indexing system. That is not correct, however. The claimed indexing mechanism rotates through one degree of freedom to index the balls from one station to the next. This is significantly more efficient and mechanically trouble-free than the pick-transfer-place method taught by Mitoma. The claimed single degree of freedom indexing mechanism also requires the stations to have parallel axes, which again, is a feature not taught or suggested by Mitoma.

White teaches an inspection system that uses mirrors to allow one camera to image more than one surface of a part, and the camera described is an area scan "video" camera. White does not teach or suggest how to apply the line scan camera so that it can simultaneously image two spherical objects that are spinning on separate, parallel axes; nor does he address the issue of depth-of-field that is created by his mirror system. In contrast, the claimed mirror arranged maintains the same focal distance t o each ball so that depth of field is not an issue. In order to properly image a spherical object with a line scan camera the line sensor must be in line with the spin axis. For this application, the two spin axes must be positioned by the mirrors so that they both line up with the axis of the line sensor element in the camera. The balls must be positioned to also maintain the maximum use of the line sensor so that adequate resolution is maintained. The claimed invention enables this, while White and the other references neither teach nor suggest this.

In addition to the foregoing, it is noted that while Mitoma teaches a system that uses two rotation stations for imaging the ball, followed by two positioning stations, the presently claimed method of orienting a ball in three dimensions, using the three Euler angles, is neither taught nor suggested by Mitoma. Mitoma's two positioning stations can only position the ball in two dimensions, i.e., the equator can be positioned horizontally but the ball will not be oriented around the axis that is perpendicular to the equatorial plane. Therefore a target "point" on the ball cannot be positioned (as it can be in the claimed invention); only a target "great circle" can

be positioned by Mitoma's structure. And again, Mitoma does not teach or suggest rotating the ball through a 90 degree angle.

More particularly, Mitoma teaches a system in which a ball is rotated about two perpendicular axes ST3 and ST4, and then fine-adjusted about two more perpendicular axes at station ST5. Mitoma's first two stations ST1 and ST2 are used only for rotating the ball to acquire the image, and no positioning is done at those stations. Thus, Mitoma does not teach or suggest either orienting the ball in three dimensions or using a set of three Euler angles required to orient the ball in three dimensions. Mitoma teaches orienting the ball in two dimensions over two positioning stations ST3 and ST4, while the claimed subject matter uses three Euler angles to orient the ball in exactly three stations. The second Euler angle has 90 degrees added to it to allow it to work with stations that have parallel axes of rotation -- again, a feature not present, taught or suggested by Mitoma.

With regard to claims 26, 27 et seq., it is noted that the claimed system utilizes what information is available from the first imaging station to position the ball so that all the necessary information will be attained at the second imaging station to successfully orient the ball in exactly three moves. The first imaging station ensures that the desired indicia will be found at the second station. In Mitoma, in contrast, there is no locating done at the imaging stations. If the ball's equator is not found at the first imaging station it is assumed that it will be found at the second imaging station. There is no teaching or suggestion in Mitoma of using information from a first imaging station to position the ball so that all the necessary information will be attained at the second imaging station to enable successful orientation of the ball, in three dimensions, in exactly three moves, as required by the claims.

Similarly, Mitoma teaches a system where the two imaging axes are perpendicular and (their stations) are mechanically quite different from one another. As a result, Mitoma's means to index the ball from one station to the next requires three moves per transport over two degrees of freedom: i.e., lift, transfer, and place. This is far more complex and potentially slower and more trouble-prone (borne out in real-world observation of the actual machines as noted below upon Applicant's direct observation and knowledge), than the claimed invention. As required by the claims, the Applicant's invention uses the more efficient method of indexing the ball by rotating it through one degree of freedom to simultaneously transfer the ball and present it to a second, mechanically identical station, so that the axis of rotation of the ball at the second station

is perpendicular to the previous axis of rotation, while the two stations rotate on parallel axes. The teachings of Mitoma are thus fundamentally different and in fact, diametrically opposed to the mechanisms and methods required by the claims.

It is also noted that in addition to its complex transport arm mechanism, Mitoma teaches a system that uses vacuum to hold the ball while it is transported from one station to the next. In the Applicant's claimed invention, in contrast, the vertical moving cup 14 of Mitoma that serves the purpose of controlling the center of the ball, and adds significantly complexity to Mitoma's stations ST2 and ST4, is not required. Moreover, claims 1, 10, and 27 recite structures in which multiple workstations are identical, thus further providing a combination of structures and features that is not taught or suggested by any of the cited art, taken separately or in combination.

With regard to Gordon, the system described therein is based on using an iterative process to orient the ball. The Gordon machine repeatedly images the ball and moves it based on what it "sees" until the ball is in the correct or nearly correct orientation. As noted below based on the Applicant's real-world knowledge and observation of the various actual machines built in accordance with the Gordon design, the Mitoma design, and the Applicant's claimed invention, the Gordon system results in variable times to orient the ball, instead of a uniform and predictable orientation time, resulting in downstream challenges for the machine. The Applicant's claimed invention, in contrast, uses exactly three moves, with a predictable time interval, to orient the ball.

In view of the foregoing, the Applicant respectfully asserts that the subject matter of the amended claims is neither taught nor suggested by the cited references, taken separately or in combination.

Video Demonstration: Many of the clear differences between the present invention, as claimed, and Mitoma, for example, can be seen by carefully comparing the Applicant's FIG. 7 with, e.g., Mitoma's FIG. 1. Further, a brief video demonstration of the invention in operation is provided at the website of the Applicant's company, at the following link: http://www.strategic-automation.com/Robo-Logo.wmv . The Applicant can also provide a more detailed video of the claimed invention in operation, for consideration by the Examiner. Given the dynamic and high-speed nature of the machine constructed in accord with the claimed invention, a video can be useful to clearly see the multiple differences between the claimed invention and the cited references.

The Present Invention Has Enjoyed Considerable
Commercial Success Owing to the Subject Matter of the Claims

As additional evidence of the non-obviousness of the subject matter of the claims, it is noted that the present invention has enjoyed considerable commercial success, and that such success is directly attributable to the subject matter of the claims, and that this success has been due to industry-acknowledged advantages of the present invention over the structures taught and disclosed in the Mitoma and Gordon references discussed above.

Declaration: The Applicant is filing herewith a Declaration attesting to the invention's commercial success and to other elements of the nonobviousness of the claimed invention over the cited references.

In particular, inventor Ralph L. Carlson has worked in this area of technology for many years, including for the Titleist company (hereinafter "Titleist", which is now the Acushnet Company, an operating company of Fortune Brands, Inc.). Mr. Carlson is unquestionably an expert in this area of technology and has personal knowledge and observations relating to machines constructed in accordance with the Mitoma and Gordon disclosures. On information and belief, Titleist purchased a burr-removing machine described in the Mitoma reference, in or about 1995, but later substantially ceased to use the Mitoma device. On information and belief, Titleist continued to have a need for a machine to orient finished golf balls so that a custom logo could be printed on them in the correct location relative to the previously-placed manufacturer's printing. On information and belief, Titleist hired Gordon (i.e., an inventor named in the Gordon reference noted above) to design the machine later described in the Gordon patent. The Gordon machine orients the ball at one station so that the machine can keep trying until the ball is successfully oriented. This allowed a higher orientation success rate, but caused the time required to orient the ball to vary significantly from one ball to the next, a significant problem for downstream processing.

Moreover, the average cycle rate with the Gordon machine was still less than half of what is achieved by machines constructed in accordance with the Applicant's invention. Thus, until the advent of Applicant's invention, the industry still had a long-felt need to orient golf balls in all three dimensions at a high operating rate and over a highly repeatable time interval, which was not achieved by machines constructed in accordance with the Mitoma or Gordon references.

The Applicant recognized that the sequential approach, described and claimed in the Applicant's present patent application and not present in the prior art, was the best way to achieve higher operating rates, and devised the claimed method of using four identical, rotating stations and the rotating grippers that index the balls through the machine while simultaneously rotating them 90 degrees. These features, as recited in and required by the claims herein, is a key advantage of the claimed structures and methods. The Applicant also incorporated a mirror design as a means to reduce the cost of building the machines.

As a result of these differences and substantial improvements and technical advantages over the prior art, the Applicant has to date sold at least thirteen (13) machines constructed in accordance with the claimed subject matter to customers including Titleist and most of the other major golf ball manufacturers, with total sales thereof in excess of $1.3 million, and expects such sales to continue into the future. There exist numerous applications for this technology in golf ball manufacturing. It is the Applicant's observation that there appear to be no other machines currently on the market that use machine vision to orient the ball.

Conclusion

The amended claims differ substantively and patentably over the cited Mitoma, Gordon, White, Petry, Welchman, and other art of record.

With respect to Mitoma, for example, that reference clearly teaches a system where the two imaging axes are perpendicular and their stations are mechanically quite different from one another. As a result, Mitoma's means to index the ball from one station to the next requires three moves per transport over two degrees of freedom: i.e., lift, transfer, and place. This is far more complex and potentially slower and more trouble-prone (borne out in real-world observation of the actual machines as noted herein upon Applicant's direct observation and knowledge), than the claimed invention. As required by the claims, the Applicant's invention uses the more efficient method of indexing the ball by rotating it through one degree of freedom to simultaneously transfer the ball and present it to a second, mechanically identical station, so that the axis of rotation of the ball at the second station is perpendicular to the previous axis of rotation, while the two stations rotate on parallel axes. The teachings of Mitoma are thus fundamentally different and in fact, diametrically opposed to the mechanisms and methods required by the claims. Mitoma teaches away from, and does not anticipate or render obvious, the subject matter of the claims presented and discussed herein.

This Amendment attends to each point raised in the pending USPTO Action; and the Examiner is respectfully requested to allow the claims.

Please charge any claims fees or other amendment fees required hereby to the above-noted Deposit Account used in connection with filing this Amendment. If there are any questions, the Examiner is cordially invited to contact the undersigned by telephone as noted below.

Respectfully submitted,

/David Jacobs/

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